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Stress density model validation: calibration and preliminary 2D results

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Stress-Density Model

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- Liquefaction constitutive model
- Fully coupled dynamic analysis
- Available in finite element and finite difference platforms (DIANA-J, OpenSees, FLAC)
- Based on state concept using an state index
- Using one set of parameters for any calibrated soil

Calibration

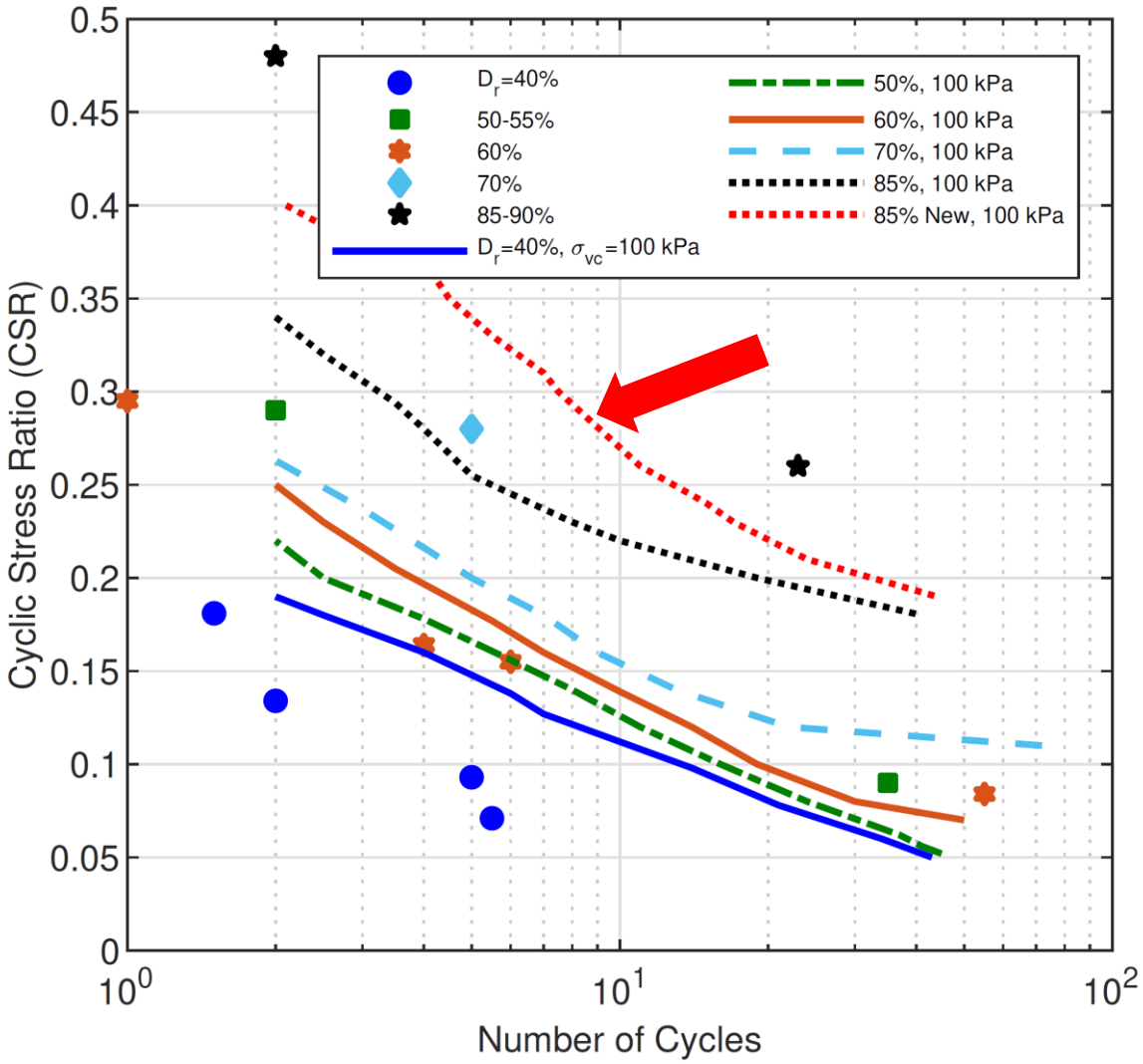
- Defalut stress-strain parameters are used.
- Re-calibrated for the dense layer to achieve less contractive behaviour

- {Lab data from: Castro 2001, Kammerer 2000, Arulmoli et al. 1992, Kutter et al. 1994}

Relation	Parameter	Symbol	Loose, Dense Nevada		Toyoura	
Elastic parameters	Shear constant	A	250		250	
	Poisson's ratio	v	0.3		0.2	
	Exponent	n	0.55, 0.60		0.6	
Reference lines	UR-line (void ratio and normal stress in kPa)	e_U, p	0.879	<400	0.895	<400
	QSS-line (void ratios and normal stress in kPa)	e_Q, p	0.859	1	0.877	1
		e_Q, p	0.848	10	0.877	10
		e_Q, p	0.831	30	0.873	30
		e_Q, p	0.825	50	0.87	50
		e_Q, p	0.814	100	0.86	100
		e_Q, p	0.803	200	0.85	200
		e_Q, p	0.79	400	0.833	400
Stress-strain parameters	Peak stress ratio coefficients	a_1, b_1	0.592	0.021	0.592	0.021
	Max. shear modulus coefficients	a_2, b_2	291	55	291	55
	Min. shear modulus coefficients	a_3, b_3	98	13	98	13
	Degradation constant	f	4		4	
Dilatancy parameters	Dilatancy coefficient (small strains)	μ_0	0.27, 0.20		0.22	
	Dilatancy coefficient (cyclic)	μ_{cyc}	0.017, 0.015		0	
	Critical state stress ratio	M	0.581, 0.581		0.607	
	Dilatancy strain	S_c	**0.0052, 0.0065**		0.0055	

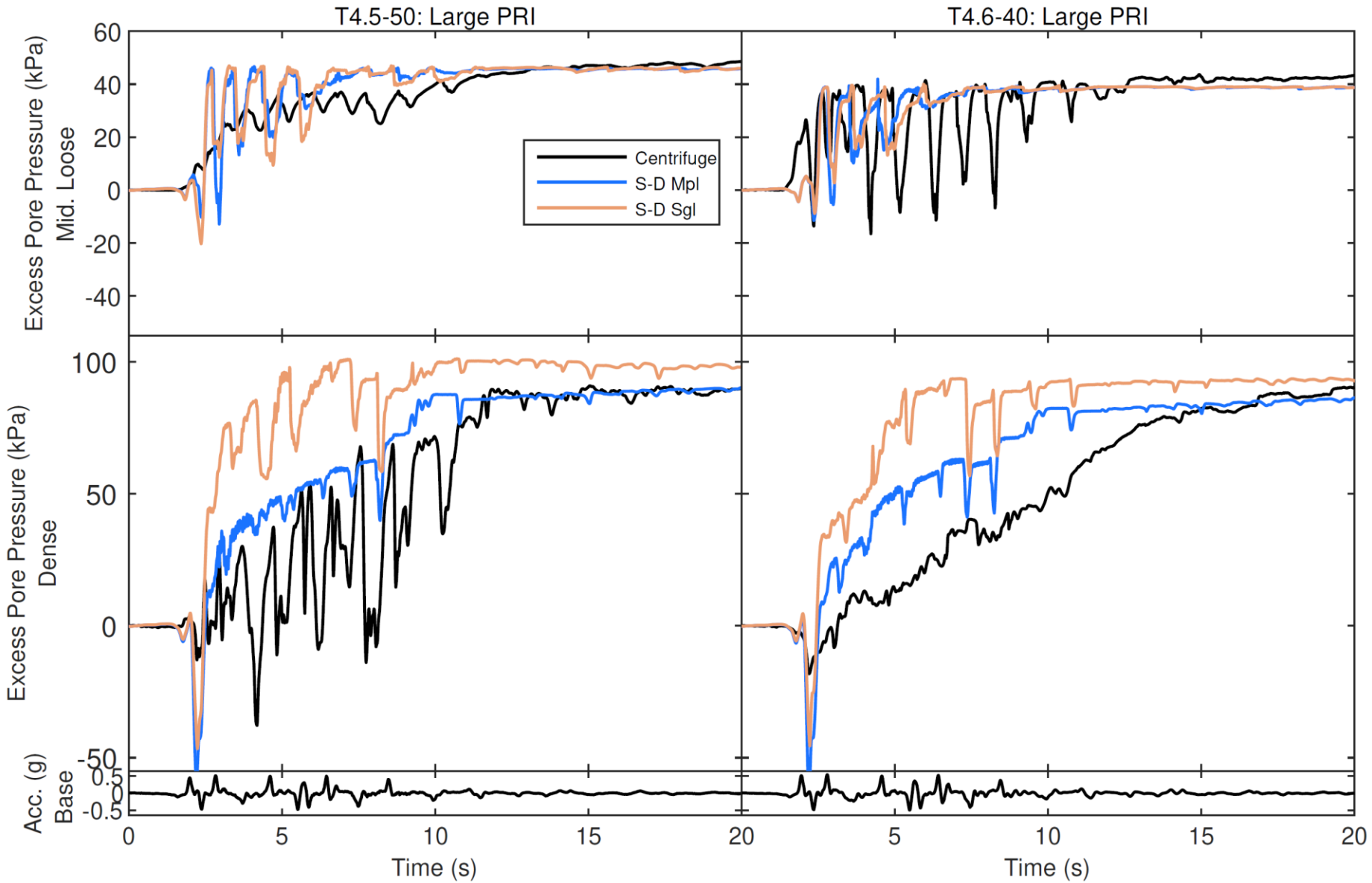
Liquefaction Resistance Curve

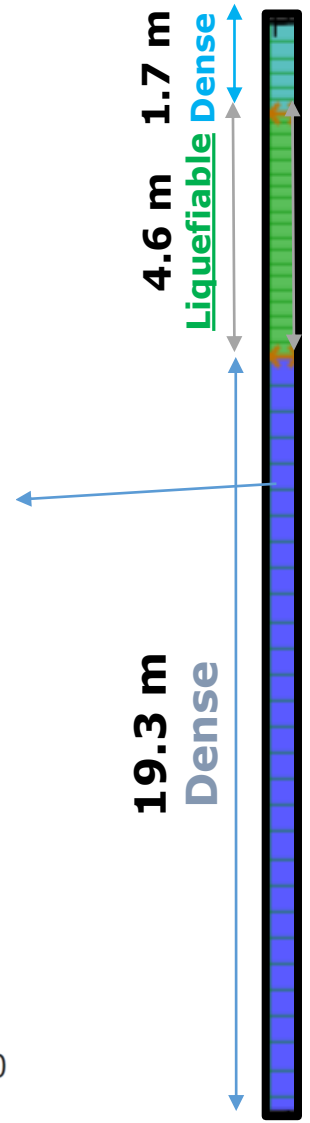
- Increasing Sc leads to less contractive behaviour
- Significant increase in the liquefaction resistance of dense layer



Cyclic simple shear results of Nevada sand from numerical simulations (lines) and experimental tests (symbols)

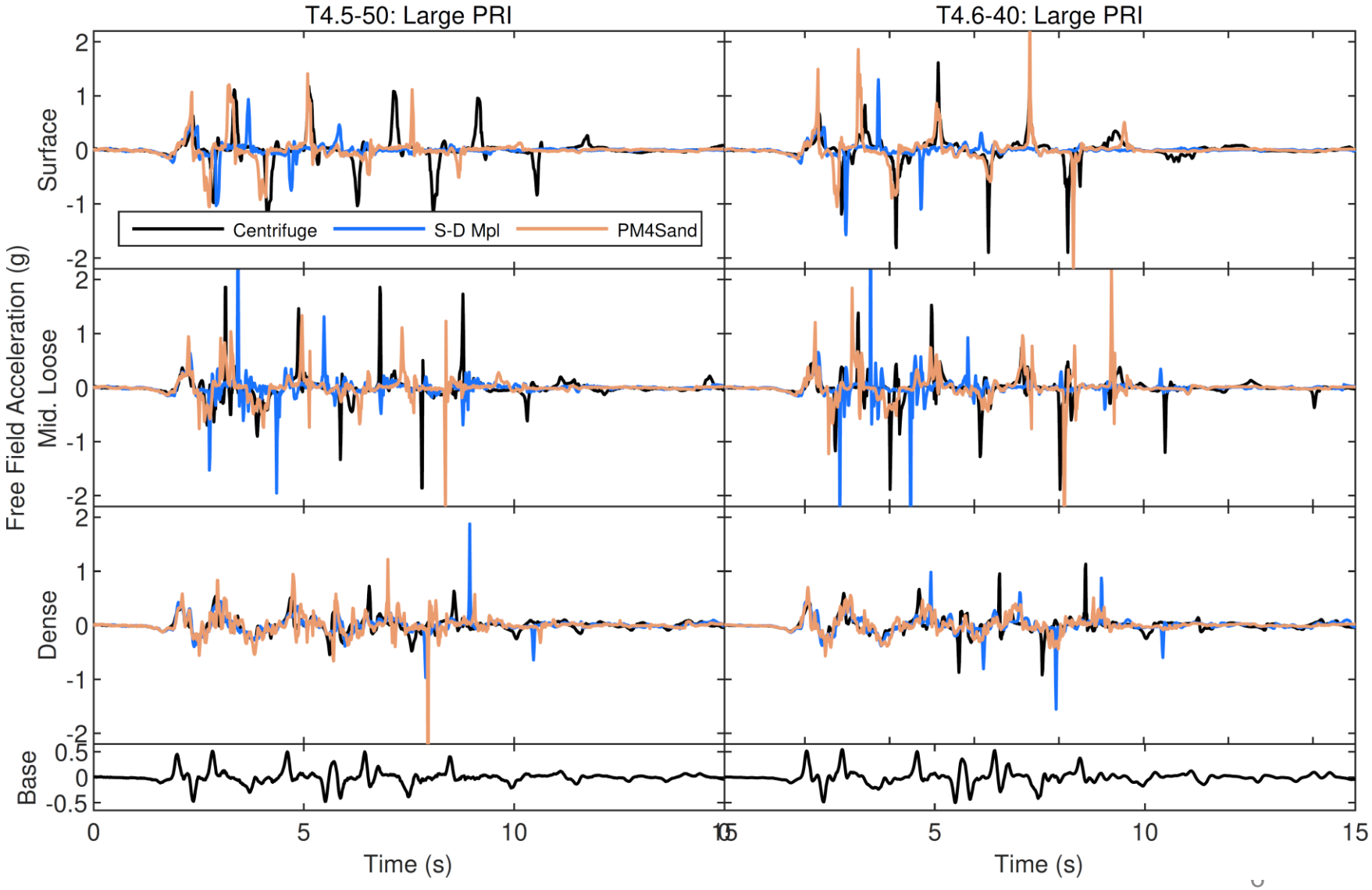
Results: Excess Pore Water Pressure





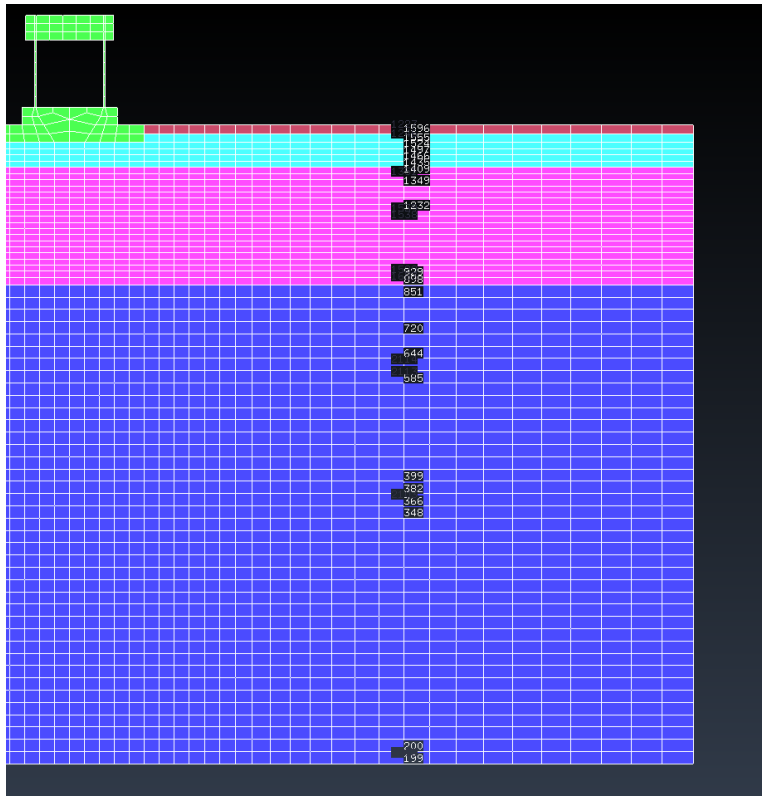
Results: Acceleration

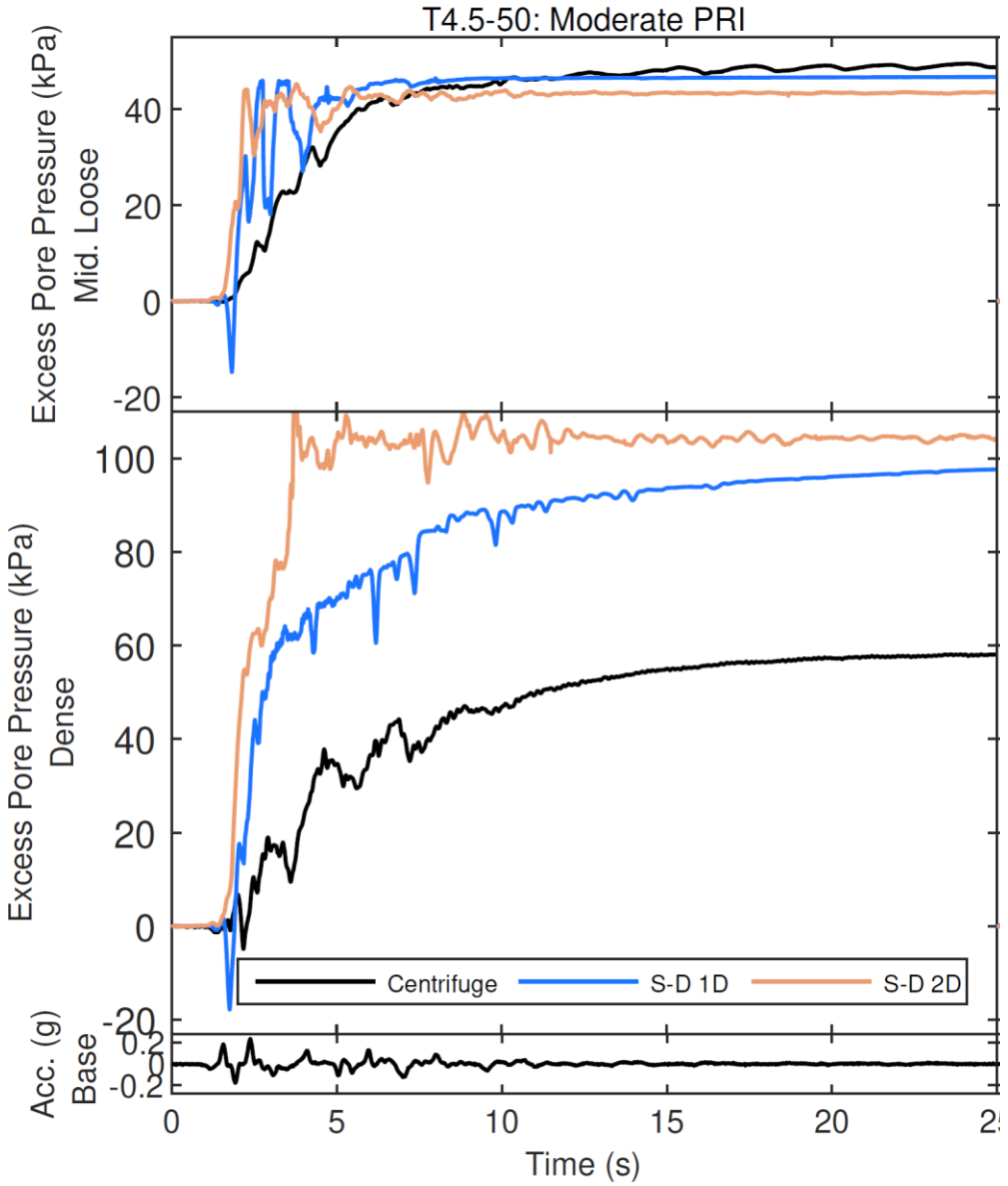
- Room for improvement in the dense layer
- The effect on the liquefiable layer and surface is small



Preliminary 2D Results: PWP

- Overpridction at the dense layer and undeprediction in the loose layer





Summary

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- Rigorous calibration based on high-quality lab data is crucial.
- PWP build-up prediction improved significantly in the dense layer.
- The effect on the loose layer was small
- Currently: 2D validation with structures (SSI)

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Thank you

Questions?